NEW SOUTH WALES.

DEPARTMENT OF PUBLIC HEALTH.

REPORT

ON

PROTECTIVE INOCULATION AGAINST TICK FEVER.

An Account of an Experimental Inquiry into its Effect on Cattle, and on Meat and Milk; together with some Notes on Protective Measures other than Inoculation.

BY

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SYDNEY, DECEMBER 29TH, 1898.

SYDNEY: WILLIAM APPLEGATE GULLICK, GOVERNMENT PRINTER.
1899.
37594

The Chief Medical Officer of the Government and President of the Board of Health to the Right Honourable The Premier and Colonial Treasurer.

Department of Public Health,
Sir, Sydney, 9 January, 1899.

I have the honour to present herewith a report by the Principal Assistant Medical Officer of the Government, on the effects produced on the meat and milk of cattle protectively inoculated with the virus of Tick Fever, and to suggest that it might be communicated to the Honourable the Minister for Mines and Agriculture, at whose instance the inquiry was undertaken.

2. The conclusion reached is that inoculation by the method now in use causes no permanent alteration either in quantity or quality of the meat and milk of cattle submitted to it. The importance which this knowledge has at a date when invasion of the tick is probably imminent, and when, consequently, it is necessary in the common interest that every real or imaginary obstacle to the systematic practice of inoculation should be removed, scarcely needs to be pointed out.

3. The report is confined as nearly as possible to the matters of which elucidation was specially desired. There are others of great importance which have not yet been systematically examined; and therefore, at the same time that the experimental method followed by Dr. Frank Tidswell is pointed out as the only one which can give trustworthy results, it should be mentioned that the present plan of protective inoculation against natural Tick Fever, which was devised several years ago in the United States, and which has recently been practised in Queensland on an extensive scale, stands much in need of similar investigation. It may turn out that it is not susceptible of improvement; but in the meantime it is easily conceivable that it might be made more manageable in use, and perhaps rendered safer and still more effectual.

I have the honour to be,

Sir,

Your obedient Servant,

J. ASHBURTON THOMPSON.

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PROTECTIVE INOCULATION AGAINST TICK FEVER.

An Account of an Experimental Inquiry into its Effects on Cattle, and upon Meat and Milk; together with some Notes on Protective Measures other than Inoculation.

⁂ The experiments performed at the Maritime Quarantine Station, Sydney, and described in this report, were commenced on 15th July, 1898, and terminated on 25th November, 1898. They profess to deal only with the immediate effects of inoculation. The remote consequences, if there be any, can only be determined by a much greater lapse of time than the experiments covered. Some of the animals are being kept under observation, and any further effects of inoculation shown by them will be duly reported.

INTRODUCTION.

In the opinion of those competent to judge, the invasion of New South Wales by the Cattle Tick, and so by Tick Fever, is inevitable, and the steady southward progress made by the ticks in Queensland suggests that the time of their advent may be in the near future. Impressed with the calamitous consequences of tick infestation to the herds in the north, stockowners in this Colony have expressed the desire to supplement the measures already taken by the Government by the protective inoculation of their cattle.

At the present time this operation, which involves infection with living micro-organism, is prohibited by the Animals Infectious Diseases Act, 1888 (51 Vic., No. 30, section 4). In considering the advisability of permitting its practice, there cropped up the question of its effects on meat and milk. It was found that information on these aspects of inoculation was scanty, vague, and of the hearsay order. In view of the paramount importance of the interests involved, it was considered desirable to become possessed of more precise facts. With this object an experimental inquiry was undertaken by the Health Department, at the instance of the Hon. the Minister for Mines and Agriculture.

The experiments, of necessity, covered more than their particular objects. Their successful conduction demanded an acquaintance with inoculation in general. In order to make the additional information gleaned accessible to all interested, the scope of this report had to be enlarged beyond the original intention. It now includes data concerning all the more important issues of the question. In its compilation use has been made not only of the results of our own experiments but also of those obtained by other investigators. In every case where such importations have been made, the source is duly acknowledged by reference to the list of literature at the end of the report.

The details of our own work are given in the records of observations in Appendix 2, extracts from which are presented in the report itself as illustrations of the various points under discussion. Appendix 1 consists of charts upon which are shown in graphic form the relationships of the three principal features of the inoculation illness in dairy cows.

As protective measures other than inoculation must play their part in our plan of resistance to the invasion of ticks, some information concerning them, gathered principally during a recent visit to Queensland, has been incorporated into this report. It is hoped that this inclusion will not prove unacceptable. The writer's thanks are due to the Hon. J. V. Chataway, Minister for Agriculture, Mr. P. R. Gordon, Dr. J. Sydney Hunt, Mr. C. J. Pound, and other gentlemen, for the cordial reception, and unstinted help accorded to him during his visit to Queensland.

The valuable professional services and advice of Mr. J. D. Stewart, M.R.C.V.S., Veterinary Surgeon to the Stock Branch, and the untiring aid of the assistants in the Sydney experiments, Messrs. Grant, Crouch, and Brown, are also gratefully acknowledged.

PART 1.—NATURAL TICK FEVER.

A.—The Rôle of the Ticks in Natural Tick Fever.

(a) *Names and Distribution of Natural Tick Fever.*

The disease with which this report is concerned was called Texas or Southern Cattle Fever by the American observers who first described it (1).* In Australia it is more generally known as Tick Fever or Cattle Tick Fever. It is said to occur also in Jamaica (2), the Argentine Republic (3), South Africa (1), Roumania (1), and Java (3). The identity of the disease in these various places is now regarded as established. The Australian name of Tick Fever has become attached to it owing to the part played in its dissemination by the cattle tick.

(b) *Ticks are the Natural Transmitters of the Disease.*

The exact relationship of the tick to Tick Fever was definitely demonstrated by the masterly researches of Smith and Kilbourne, an account of which was published in 1893 (1). These observers showed that Texas Fever is not communicated directly from animal to animal, but that the cattle tick is necessary to its transmission. Healthy animals can be safely associated with sick ones provided all ticks be removed from the latter beforehand. If the ticks be not so removed, the healthy animals become infected and suffer from tick fever. Pastures previously "clean" became infected when occupied by the ticks, either as a natural event, or by the artificial scattering of ticks over them.

(c)

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* The numbers refer to the list of literature at the end of the report.

(c) *The Disease can be artificially produced by the Inoculation of Blood from a Sick Animal.*

The observations just mentioned apply to the disease as it occurs in the ordinary course of nature. It was shown, however, that the disease can be set up artificially by injecting blood taken from a sick animal under the skin, or into the veins, of a healthy one. The disease could be thus transmitted through a series of any number of animals. The blood was found to retain its infective properties after the apparently perfect recovery of the animal from tick fever.

It was therefore made clear that the tick is not the essential cause of the fever, and further investigations showed that the real agent is a micro-organism which lives in and upon the blood of affected animals. To this micro-organism Smith and Kilbourne gave the name of *Pyrosoma bigeminum*, on account of its microscopical appearances. Its constant presence in the blood of animals suffering or recovered from tick fever furnished the explanation of the infectivity of the blood when artificially injected.

(d) *In nature Ticks carry and Inoculate the Micro-organism.*

Numerous experiments indicated that in nature the disease can only be conveyed by the cattle ticks,* which it is presumed, inoculate the micro-organism in much the same way as can be done with the injection syringe. It was found that the micro-organisms are transmitted from the old ticks through the eggs and young to any cattle to which these particular young ticks happen to attach themselves. Adult female ticks taken direct from sick cattle laid their eggs in glass boxes kept in the laboratory. In due course the young ticks hatched out, and they produced the disease on being placed on healthy cattle in stables away from all infected ground. Hence it appears that the adult tick in withdrawing the blood of infected cattle takes with it the micro-organisms, and that these are transferred through the eggs to the next generation of ticks. The fact that each female usually lays over 2,000 eggs explains the way in which the disease becomes widely disseminated.

The micro-organism, though discoverable in the blood of all infected animals, has not been detected in the bodies of the ticks, possibly on account of its assuming a different, and as yet unknown, form in the tick. When, where, and how the micro-organism first became associated with the tick is unknown. The association is accidental, for there are ticks which do not produce tick fever.

(e) *Comment.*

The American researches established the *rôle* of the tick in tick fever. The tick is the means by which the real causal micro-organisms gets into the blood of cattle, and also the means by which it eventually gets out again. The researches of Dr. J. Sidney Hunt, Government Pathologist, and Mr. C. J. Pound, Director of the Stock Institute, Brisbane, have shown that the American results apply also to the disease as it occurs in Queensland.

The intervention of two different parasites, the tick and the micro-organism, in the causation of tick fever, though marvellous, is not without parallel in the realm of disease. Similar symbiotic *rôles* are played by the Tse-tse fly and the micro-organism of the African cattle disease, "Nagana"; by the mosquito and the micro-organism of malaria; and, it is said, by the common flea and the micro-organism of plague. In all four cases the production of the disease is not an essential attribute of the insect concerned, but a fortuitous circumstance due to their capability of acting as conveyors of the real pathogenic microbe. There are cattle ticks which do not communicate tick fever, just as there are mosquitoes which do not communicate malaria.

B.—Immunity after Natural Tick Fever.

(a) *Certain animals possess natural immunity.*

Tick fever is not known to attack animals other than bovines. Ticks attach themselves to horses, sheep, marsupials, birds, snakes, &c., and may even mature upon them (7), but they do not set up tick fever in these animals. The animals appear to be, by nature, insusceptible to the disease, and hence are said to possess natural immunity.

It must be admitted that some doubt exists in the case of sheep. The American observers came to the conclusion that sheep were not susceptible, but they only report one experiment in which blood was injected into a lamb (1, page 83). By similar experiments on two sheep in Queensland, Dr. Hunt set up a fever in both. One recovered, and one was killed in a dying state. *Post-mortem* examination did not reveal the characteristic lesions of tick fever, and the examination for micro-organisms was indefinite. The blood from one of the sheep injected into a bullock "produced no well-marked disease" (7, page 28). The evidence is, perhaps, no more than suspicious, but it is possible that tick fever, like tuberculosis, occasionally occurs in sheep. As Dr. Hunt remarks, the subject merits further study.

(b) *Cattle are naturally susceptible, but come to possess an acquired immunity after having suffered from the disease.*

Cattle are by nature susceptible to tick fever; but, after having suffered from it, they exhibit more or less resistance to a second attack. They come to possess an acquired immunity.

In America the permanent distribution of ticks is limited to the States south of a boundary known as Salmon's line. Although the cattle south of this line are always more or less tick infested, they show no visible signs of having tick fever. But immediately northern cattle are taken to the south the ticks invade them and set up tick fever. The absence of fever in the south is not due to lack of virulence on the part of the ticks, but to the immunity of the southern cattle.

(c) *American Experiments on Immunity.*

The American observers furnished the proof that this immunity of Southern cattle was not natural, but due to previous attacks. Their experiments were performed by the exposure of Southern cattle to the ticks at the Experimental Station, near Washington. A steer, aged 2 years; 3 heifers, aged $1\frac{1}{2}$, 3, and 3 years; and 5 cows, aged 5, 5, 5, 4, and 6 years, from North Carolina and Texas, were exposed, with negative results in all cases, whilst northern cattle exposed at the same time all took the disease. Two of the southern cows had calved after their arrival at the station, and the calves were exposed with the mothers. Both calves took the fever. Although descended from immune parents, the calves were not themselves immune. The experiments thus show that the immunity of the southern cattle is not natural, but acquired. Another

* Nothing is known as to the possibility of other suctional insects spreading the disease.

Another series of experiments showed that northern cattle, originally very susceptible, became more or less immune after having passed through an attack of the disease. In these the method was to re-expose the animals to ticks one or two years after the first attack. The results of the first and subsequent exposures are summarised in the following table, compiled from the account (1, pp. 132–4). The kind of attack is stated in the author's own words under the column referring to the year in which it occurred :—

TABLE I.—Showing results of Exposure and Re-exposure to Ticks (Smith and Kilbourne).

Kind.	Age.	1889.	1890.	1891.	1892.
	Yrs.				
Heifer	$1\frac{7}{12}$	Prolonged	Probably not affected.	...	...
Do	2	...	Prolonged, acute	Negative	Fairly severe.
Do	2	...	...	Short, acute	Negative.
Do	2	...	...	Acute	do
Cow	$2\frac{1}{2}$	Fairly severe	Probably not affected.	...	...
Heifer	$2\frac{1}{2}$	...	Doubtful	Acute.	...
Do	$2\frac{1}{2}$	...	Acute	...	Fairly severe.
Steer	3	Mild	Prolonged, mild.	...	...
Cow	$3\frac{1}{2}$	do	*Mild.	...	...
Heifer	$3\frac{1}{2}$	...	...	Acute	Slight ?
Do	$3\frac{1}{2}$	...	...	† do	Mild, short.
Cow	4	Mild	Acute.	...	...
Steer	4	...	Prolonged, mild	Short, acute	Slight ?
Cow	$4\frac{1}{2}$	Severe	Acute, died.	...	...
Do	6	...	Severe	Acute, died.	...
Do	7	...	Acute	?	...
Do	7	...	...	‡Acute	Negative.

* Died some time after. † Intravenous injection of blood. ‡ Inoculation of blood under skin.

Of the 17 animals experimented upon 10 took the fever, and 3 died; the other 7 "remained practically unaffected."

(*d*) *Immunity after a Single Attack is only Partial, but it becomes Perfect after Repeated Attacks.*

In the two sets of experiments to which attention has just been directed, there was exhibited an important difference in degree between the immunity of the southern animals, in which it was perfect, and that of the northern animals in which it was only partial. The greater immunity of the southern animals is regarded by the authors as being due to frequently repeated infection by ticks, commencing when the animals are very young. The insufficiency of the immunity resulting from a single attack is commented upon in the following terms:—"It is not to be denied that in the case of animals not more than $2\frac{1}{2}$ or 3 years old a first mild attack may prevent a second fatal attack in many cases, and a first acute attack may be followed by a very mild infection, but it may be laid down as a general proposition that a single attack is not sufficient to produce complete immunity."

(*e*) *The duration of the immunity has not been finally determined.*

The time the immunity lasts after removal from all possibility of reinfection presumably differs in accordance with the number of previous attacks, but there are no definite statements to this effect. The American observers note that southern cattle are said to become "liable to be attacked, after having been away from the permanently infested territory for a year or longer." (1. p. 130.) In their own experiments they found the animals retained their immunity for two years. From the results stated in the table given above it appears that after a single attack the immunity was sometimes retained for a year at least, although there is also evidence of its failure in the second year. But even then it seemed sufficient to avert a fatal attack, in the younger animals at all events. There are no available data for the settlement of this point, but it is probable that the protection extends over a year or two.

(*f*) *Comment.*

The American researches definitely showed that cattle can acquire immunity against tick fever, but that the immunity only becomes perfect after repeated attacks. Nevertheless the immunity conferred by a single attack, although not always preventing fever, may prevent death from a second attack. The extensive observations recently made in Queensland have led to similar conclusions.

PART 2.—PROTECTIVE INOCULATION.

A.—VALUE AS A PROTECTIVE MEASURE.

(*a*) *American authorities advised a mild attack of Tick Fever as a protective measure.*

The desirability of possessing even the partial immunity which a single attack confers has led to the introduction of inoculation as a protective measure. Smith and Kilbourne, whilst not greatly favouring the procedure, recognised its worth as a means of protecting valuable animals from a fatal attack. They remark that calves are much less susceptible than older animals, and would probably survive without treatment, but "in the case of animals more than 12 to 18 months old the first attack might be fatal, and if a preliminary mild attack could be induced by artificial means the fatal effect of a second attack might be averted." The means they advised, were that the animals be exposed to an attack in the autumn, when the disease will probably be mild and not likely to cause permanent injury. They recommend that the disease be set up either by exposure to ticks, or by inoculation. (1 p. 136.) They incline to favour the former process as being simpler and not involving operation.

(*b*)

(*b*) *In Queensland the method of inoculation is used, but a distinction is drawn between "virulent" and "recovered" blood.*

In Queensland the climatic conditions favourable to mild attacks by ticks are wanting, and inoculation becomes the only method possible In Table I it is noted that two of the animals experimented upon in America, on exposure to ticks after inoculation, showed in one case complete, and in the other, partial immunity. Both were inoculated with blood taken from animals actually sick, but it is noted that the blood of southern animals remained infective for three years after the illness. It is now known that the infectivity may persist for even longer. Although the American observers thus appear to have used blood from sick animals and blood from animals restored to apparently perfect health, and to have produced the disease with both kinds, they do not seem to have been impressed with any difference in virulence between the two. Such a distinction is made in Queensland, where it has been found that blood taken during the fever ("virulent" blood) produces much more serious effects than blood taken after the fever has passed off ("recovered" blood). In our own experiments at North Head we have used both kinds, and the results indicate that recovered blood was slightly less violent in its action. However, the experiments were not designed for the settlement of this question, and our opportunities for observation were so few that no great weight attaches to them. It is believed in Queensland that the difference is a real one, but only becomes apparent when observations are made on a large number of animals.

It is not known whether there is any difference between the two kinds as to the degree and duration of the immunity conferred.

(*c*) *Queensland method and published results.*

The practice of protective inoculation in Queensland is based on the above mentioned views, and consists of injecting recovered blood in the hope of obtaining immunity at the expense of a mild attack of Tick Fever. A method of performing the operation on a large scale has been elaborated by Mr. C. J. Pound. (8.)

Some results are given in a report recently issued by the Queensland Government (4). Mention is made of the inoculation of some 35,000 head of cattle with a fatality due to the operation which is mostly stated to have been "very trifling," "very small," "practically nil," and "nil." It would appear also that most of these animals were unaffected on subsequent exposure to ticks. An effort to extract exact figures from this rather complicated document gave the following results:—

17,960 cattle were inoculated, with a loss of 679 head; a fatality equal to about 3·6 per cent.
171 bulls were inoculated, with a loss of 7 head; a fatality equal to about 4 per cent.
95 inoculated cattle remained unaffected on exposure to ticks, whilst 30 uninoculated cattle all suffered from Tick Fever.

These results must be regarded as furnishing very satisfactory testimony of the efficiency of protective inoculation.

(*d*) *Experiments performed in Sydney show that inoculation protects against reinoculation.*

Amongst the items mentioned in the Queensland report there is the inoculation of 45 bulls which withstood reinoculation without ill effect, although the blood used produced severe fever in 10 control animals Our own experiments at North Head furnish information on this point. A general statement concerning the inoculations and their results is given in Table II. The blood used in each case is designated by a symbol indicative of its source, thus:—

Blood A.—Recovered blood obtained from Queensland.
Blood B.—Virulent blood obtained from Queensland.
Blood C.—Recovered blood from Cow II of our series.
Blood D.—Virulent blood from Cow VII.
Blood E.—Virulent blood from Cow IX.
Blood F.—Virulent blood from Cow V.
Blood G.—Virulent blood from Cow XII.
Blood H.—Normal blood obtained from Glebe Island Abattoir.

The terms "virulent" and "recovered" applied to the blood are used in the sense already explained. The term "reaction" connotes that the inoculation was followed by the usual symptoms of (inoculated) Tick Fever.

TABLE II.—General Statement concerning Inoculations and results. Doses in cubic centimetres.

Cow.	First Injection.			Second Injection.			Third Injection.		
	Material.	Dose.	Result.	Material.	Dose.	Result.	Material.	Dose.	Result.
I	Blood G	50 c.c.	Reaction	...	...	...	...	...	...
II	Blood A	10 c.c.	Reaction	Blood B	10 c.c.	No reaction	Blood G	100 c.c.	No reaction
III	Blood A	10 c.c.	Reaction	Blood B	15 c.c.	No reaction	...	...	...
IV	P.C. filtrate of blood A (1).	10 c.c.	No reaction	Blood B	10 c.c.	Reaction	Blood G	210 c.c.	No reaction
V	Blood H	10 c.c.	No reaction	Blood B	15 c.c.	Reaction	Blood G	50 c.c.	No reaction
VI	P.C. filtrate of blood H (1).	10 c.c.	No reaction	Blood B	10 c.c.	Reaction	Blood G	100 c.c.	No reaction
VII	Blood C	10 c.c.	Reaction	Blood F	15 c.c.	No reaction	Blood G	100 c.c.	No reaction
VIII	Centrifugalised blood C (2).	20 c.c.	No reaction	Blood E	10 c.c.	Reaction	Blood G	100 c.c.	No reaction
IX	Blood D	10 c.c.	Reaction	...	...	...	...	...	...
X	Blood E	10 c.c.	Reaction	Blood G	50 c.c.	No reaction	...	...	...
XI	Blood E (3)	10 c.c.	Reaction	Blood G	50 c.c.	No reaction	...	...	...
XII	Blood F	10 c.c.	Reaction	...	...	...	...	...	...
XIII	Blood E (4)	10 c.c.	Reaction	Blood G	50 c.c.	No reaction	...	...	...

The symbols A, H indicate source of blood (*vide* text). (1) Obtained by passing blood through a Pasteur-Chamberland filter. (2) Supernatent liquid after centrifugalising blood for 20 minutes at rate of 4,000 revolutions per minute. (3) Injected in 10 divided doses of 1 c.c. each. (4) Injected into jugular vein; all other injections subcutaneous.

In the column headed First Injection it will be seen that certain animals, Nos. IV, V, VI, VIII, received injections of blood modified in various ways. These injections were made to elucidate some special points which will be dealt with in a later communication. In the meantime it is to be noted that they cause no reaction, and conferred no protection. On subsequent injection with unmodified blood all the animals reacted. The observations therefore furnish confirmation of the statement made by Mr. Pound in his report for 1897, namely, "that it is absolutely necessary for the animal to have had the fever in some form, in order to protect it from a subsequent more fatal attack."

The results recorded in the table show that the first inoculation with either recovered or virulent blood was followed by reaction with deadly certainty. Consequently they are in accord with the opinion that animals in this latitude will take tick fever.

The table also shows that when once a reaction had been obtained, no further reaction followed subsequent injections.

Cow II gave a reaction with blood A, but afterwards gave no reaction with blood B, which produced reaction in cows IV, V, VI, nor with blood G, which produced a reaction in cow I.

Cow III gave a reaction with blood A, but afterwards gave no reaction with blood B, which produced reaction in cows IV, V, and VI.

Cows IV, V, and VI gave a reaction with blood B, but afterwards gave no reaction with blood G, which produced a reaction in cow I.

Cow VII gave a reaction with blood C, but afterwards gave no reaction with blood F, which produced reaction in cow XII, nor with blood G, which produced reaction in cow I.

Cows VIII, X, XI, and XII gave a reaction with blood E, but afterwards gave no reaction with blood G, which produced a reaction in cow I.

The remaining animals, Nos. I, IX, and XII were used as controls.

It will be seen that in all cases after one reaction had been obtained subsequent injections failed to produce another. The first reaction had completely immunised the animals against reinoculation, even with the very larger doses which represent the severest trial we could apply in this Colony. The ultimate test of exposure to ticks is to be carried out by sending some of the animals to Queensland.

(*e*) *In practice there may be some mortality amongst inoculated animals on exposure to ticks.*

It was ascertained during a recent visit to Queensland that as a matter of practice it has been found that a certain mortality occurs amongst inoculated animals when they become tick infested. Most of them remain well, but some fall sick, and a few die. This is in accord with the American opinion that complete immunity is not conferred by a single attack of the disease.

It is questionable whether this mortality is to be altogether ascribed to failure of the inoculation method. There are at least three other influences which may be operative in its production, viz.:—

(1.) The use of unsuitable blood.
(2.) Unsatisfactory performance of the operation.
(3.) The effects of the ticks *per se.*

(1.) That the blood of every recovered animal is not suitable, has been an outcome of practical experience in Queensland. It has been found that some animals though immune themselves will not furnish blood capable of setting up the disease in other animals. No doubt the unsuspected use of such blood has contributed to the mortality amongst inoculated (?) animals on exposure to ticks.

(2) The performance of inoculation necessitates, if not operative skill, at least a clear knowledge on the part of the operator of what is required to be done. It must be systematically and thoroughly accomplished, and the actual injection of the blood must be assured. When performed on quiet animals it is not likely to fail, but the case is very different when wild, plunging cattle have to be inoculated in a crush. The operation has then to be conducted under difficulties, and here and there an animal may escape satisfactory treatment. It is possible that some of the mortality to ticks arises from this cause.

(3.) The effects of the ticks *per se.*—The greater virulence of infection by ticks over infection by inoculation induces the suspicion that the ticks themselves may have some injurious effect other than causing tick fever. It is generally stated that they have not, but this view is mainly urged on the grounds that they do not cause anæmia. The truth of this assertion may be admitted at once, since cattle will bear the sudden removal of more blood than a complete investment of ticks could deprive them of. But the argument does not appear to apply; it is not a question of anæmia, but of some other effect. The removal of blood by the ticks is so slow a process that the blood regenerative tissues have ample time to keep pace with the loss. The well-known effect of ticks upon dogs is not due to anæmia. They are often caused by a single tick, and the symptoms suggest the injection of some poison ("Tick poison"). It is true that the cattle tick belongs to a different species, and may not elaborate a poison, but the subject surely merits more consideration than it appears to have received.

Again, it has been already mentioned that tick infestment may occur without Tick Fever. This has occurred apparently at Boolburra and Mount Cornish (5). At the former place the cattle fell out of condition, and many died. Yet Dr. Hunt has found that blood from these animals did not produce Tick Fever when injected into healthy cattle, and that the survivors were not immune to Tick Fever when exposed to the fever-producing ticks at Gracemere (6). The inference is that these cattle have not suffered from Tick Fever, and that their illness was due to some other effects of the ticks. Dr. Hunt refers to such cases as "tick irritation."

Boolburra was visited by us during our inquiry. When the cattle were shaved preparatory to taking samples of their blood for microscopical examination, the skin was found to be densely covered by small areas of subacute inflammation. Similar evidence is furnished by the markings to be seen on dressed hides. It is difficult to believe that this inflammation of the skin is without influence on the cattle. Certainly in course of time cattle become "tick proof," and bear infestment without trouble, but this may be a matter of habit. It is to be regretted that more definite information is not forthcoming on this important question.

The above considerations suggest that other factors besides failure to secure immunity may play their part in the mortality of inoculated animals on exposure to ticks. Whether this be so or not, it is necessary to recognise the existence of the practical defect, and make allowance for it in considering the value of inoculation.

(*f*)

(*f*) *The duration of the immunity conferred by inoculation has not been definitely ascertained.*

There do not appear to be any facts recorded which enable one to judge of the duration of the immunity after a single inoculation. In the Queensland reports it is stated that inoculated animals were doing well in tick-infested pastures a year after inoculation, but in this case repeated infection by the ticks comes into play. Our own experiments only tell us that the immunity was not lost in a few weeks. Presumably what has been said about the duration of immunity after single attacks of the natural disease will apply more or less, and it may be assumed that the immunity will last for a year or two at least, but that it will vary in different animals.

(*g*) *Immunity can be rapidly produced.*

Nothing appears to have been said by previous observers as to the time required to produce immunity by inoculation. Attention was paid to this point in our experiments, with the result that it was found that the animals were immure to reinoculation as early as six days after the subsidence of the fever. Whether the immnnity exists still earlier could not be determined owing to the small number of animals at our disposal.

(*h*) *Comment.*

In view of all the evidence just reviewed it must be concluded that inoculation is capable of affording a decided amount of protection against tick fever. It may be that it is not absolutely certain, but this defect is of little economic importance since it depends on the advent of ticks, which, in default of inoculation, would mean losses of far greater extent.

The need for careful attention to the details of the operation, the use of suitable blood, and the necessity of obtaining a reaction, are obviously matters of great importance in the practical application of the measure. The rapid prodnction of the immunity in our experiments is an interesting result in that it demonstates the possibility of securing the protection at very short notice. In three, and possibly in all, of our animals in was produced in three weeks from the date of inoculation.

The question of the effects of the ticks themselves has been raised advisedly and dwelt upon at some length. It is an effect against which inoculation will not protect, and we may have to deal with it separately. Unfortunately the lack of definite information makes its discussion futile.

B.—The Effects of Inoculation on Cattle.

(*a*) *Successful Inoculation involves occasionally Death and invariably Illness.*

The value of inoculation is not to be decided in view of its protective influence only. The procedure involves the setting up of a disease, and it is necessary to take into account the effects of this disease upon the cattle. The performance of the operation is attended by a certain number of deaths and involves a period of illness.

(*b*) *The Inoculation Fatality is very much less than that of natural Tick Fever, is influenced by certain factors, and is irregularly distributed.*

The fatality from natural tick fever is between 60 per cent. and 70 per cent. The fatality after inoculation is usnally between 3 per cent. and 5 per cent.

The result of the operation is influenced by certain factors, the most important of which are age, sex, condition, season, nourishment, and management of the cattle. The statements concerning these influences are briefly as follow :—

Age.—Smith and Kilbourne state that young animals are largely proof against fatal natural infection (lp. 148), so that it is not surprising to learn that calves stand the inoculation well, and may generally be safely treated. The fatality after inoculation is mostly amongst the older animals.

Sex.—For some unexplained reason bulls are extremely susceptible, and apt to succumb to inoculation unless very carefully looked after.

Condition.—Very fat and very thin animals are more affected than those in medium condition.

Season.—The effect of season does not appear to play such an evident part in Queensland as it is said to do in America, but it is generally considered that the reaction is liable to be more severe during hot weather.

Nourishment.—Good food and water are regarded as most important in diminishing the fatality.

Management of the Cattle.—The cattle fare best when inoculated on their own pastures. When taken to new ones time should be given for them to settle down before commencing the treatment. The operation should be carried on methodically and quietly, avoiding excitement and rush as much as possible. After the operation the cattle should not be driven or worried, but allowed to return quietly to their pastures and remain there undisturbed for at least a month.

When these conditions are fulfilled the fatality may be nil. This was the case in several instances recorded in the Queensland report (4), and in our own experiments at North Head. Under other circumstances the result may be very different. Inquiries made in Queensland indicated that in individual lots of cattle the fatality was sometimes much above the average, reaching 25 per cent. or more, and this without any specially unfavourable conditions. The result is variable notwithstanding every precaution. It would appear, therefore, that although taken as a whole the fatality is slight, it is irregularly distributed, falling heavily upon some and lightly upon others.

(*c*) *The inoculation illness is really modified Tick Fever, all symptoms being milder.*

In order to secure protection it is essential that a " reaction " be obtained, that is, that the animal must have an attack of Tick Fever. The symptoms exhibited during this inoculation illness are the same in kind as in natural Tick Fever, bnt milder in degree. Their nature may be illustrated by the observations made in our own experiments. Only the moro important of them will be considered here, those more deeply interested will find full details in the Records of Observations in Appendix 2.

The three principal features of the inoculation illness are,—

(1.) Fever and its accompaniments.
(2.) Bloodlessness or anæmia.
(3.) Changes in the urine (" redwater.")

(1.) The degree and progress of the fever in our cases may be judged from the statements in Table III which shows the effect of the inoculation on the temperature. Table

TABLE III.—Showing effect of Inoculation on the Temperature. Quantities in degrees Fahrenheit.

Cow.	I Blood G.		II Blood A.		III Blood A.		IV Blood B.		V Blood B.		VI Blood B.		VII Blood C		VIII Blood E.		IX Blood D.		X Blood E.		XI Blood E.		XII Blood F.		XIII Blood E.	
	M	E	M	E	M	E	M	E	M	E	M	E	M	E	M	E	M	E	M	E	M	E	M	E	M	E
Extremes before Inoculation	101·2	100·5	101·4	101·6	101·7	101·7	101·2	101·2	101·3	101·4	101·3	101·4	101·0	102·0	101·1	101·3	100·7	101·7	102·1	102·1	102·1	102·1	101·7	101·5	101·7	101·8
	102·9	102·9	102·1	102·3	102·1	102·4	102·2	102·3	102·5	102·3	103·2	102·9	102·0	102·6	102·1	102·7	101·8	102·7	102·4	102·2	102·4	102·5	102·3	102·3	101·8	102·0
Temperatures after Inoculation—																										
Day 1	102·4	102·0	101·4	101·3	101·8	101·8	102·4	102·9	102·9	101·9	102·4	102·1	101·4	101·6	102·0	101·5	101·5	102·1	101·9	102·2	102·1	102·5	102·3	101·7	101·9	101·8
2	102·6	102·8	101·5	102·5	101·8	103·4*	101·7	102·0	101·9	101·6	104·4*	102·0	101·7	102·0	102·0	101·5	101·3	101·8	102·2	102·4	102·2	102·8	101·9	101·6	101·9	102·2
3	102·4	102·2	101·6	101·4	101·7	101·5	101·8	102·2	101·8	101·7	102·3	102·0	102·2	102·6	101·9	101·9	101·6	102·2	102·3	102·3	102·3	102·5	101·8	101·8	101·7	101·8
4	102·5	102·7	101·7	101·6	101·6	102·1	101·8	102·3	101·8	102·0	102·0	101·9	102·3	102·3	102·8	103·2	101·1	101·6	102·0	102·3	102·4	102·5	102·4	101·8	101·7	102·0
5	102·6	102·8	101·7	101·4	101·8	101·9	101·8	102·4	102·0	102·0	102·4	102·0	102·0	102·1	102·0	103·4	100·6	102·5	102·2	102·1	102·2	102·3	101·7	101·8	101·7	102·1
6	103·5	104·8	101·6	101·5	101·5	102·1	102·3	102·1	102·3	101·9	101·9	102·2	102·0	102·2	103·4	102·8	103·1	104·4	102·4	102·2	102·0	102·2	102·0	102·1	101·8	102·0
7	105·9	105·2	101·6	101·5	101·5	101·5	102·3	104·7	102·0	101·8	102·4	102·0	102·0	102·2	105·1	106·1	104·1	106·0	104·7	106·2	102·4	103·4	102·8	102·7	102·5	103·5
8	105·5	104·7	102·1	101·6	101·7	101·9	103·7	104·2	102·8	104·6	102·3	102·1	102·0	102·1	104·2	105·8	105·4	106·4	105·0	104·0	105·9	106·2	102·5	103·7	102·9	104·6
9	104·6	104·6	102·5	102·2	102·5	103·1	103·6	104·5	102·9	102·0	102·5	101·8	102·3	102·5	104·8	105·6	104·2	105·0	104·8	104·8	105·6	105·5	103·5	105·7	103·7	105·7
10	105·3	105·6	103·0	102·1	102·8	102·2	104·8	104·8	104·7	102·0	102·3	102·4	103·0	103·4	103·7	103·6	104·5	106·6	105·5	104·5	104·7	104·9	105·5	105·5	102·4	104·9
11	105·0	104·8	102·5	103·1	102·5	102·5	105·1	104·8	104·8	107·0	103·2	103·7	102·7	103·2	105·6	105·0	103·7	105·0	105·0	105·6	104·6	105·1	105·5	106·3	101·8	103·0
12	104·4	103·4	103·1	105·2	102·9	103·1	104·5	105·4	104·0	105·6	103·6	103·6	103·5	105·8	105·3	105·9	102·8	104·9	104·0	105·4	104·4	105·6	104·6	102·9	101·6	101·4
13	104·4	103·6	103·5	102·7	104·7	101·6	103·6	104·8	105·6	106·3	103·2	103·6	106·1	106·0	104·5	102·9	102·0	102·7	103·7	104·2	103·7	104·6	105·4	103·4	...	...
14	103·6	103·2	101·9	101·5	102·1	101·4	101·9	102·4	104·1	106·1	105·2	106·2	105·1	105·1	101·8	102·1	102·0	102·8	102·8	102·8	103·8	102·8	102·5	102·9	...	...
15	102·7	103·1	...	...	101·5	102·3	101·6	102·2	104·6	105·7	106·3	104·7	104·1	105·5	101·2	101·3	...	...	102·2	102·4	101·8	102·2	100·3	100·7	...	...
16	102·3	102·5	...	...	101·4	101·4	...	...	104·9	104·3	104·3	104·0	103·7	104·0	...	...	...	...	102·2	102·0	...	...	...	...	...	...
17	...	...	...	...	...	...	..	...	102·4	101·6	102·8	102·6	102·4	102·8	...	..	...	...	...	...	...	...	...	...	...	...
18	...	...	...	...	...	...	..	...	101·8	101·7	102·6	102·0	102·1	101·8	...	...	...	...	...	...	...	...	...	...	...	...

* Excited.

It will be seen that the febrile reaction appeared after an incubation period of between four and eleven days, the average being seven days. The maximal fever temperatures varied between 104·7° F. and 107° F., the average being 106° F. The highest points were reached between one and six days after the onset, as a rule on the third or fourth day. The fever lasted from four to ten days, the average duration being seven days.

These results agree with the observations of Smith and Kilbourne on natural Tick Fever, which showed that the fever appeared after an incubation period of a few days (1, p. 15), reached 105° F. to 108° F. (p. 16), and rarely lasted longer than eight or ten days (p. 22). The inoculation fever has the advantage of being milder.

With the rise of temperature other symptoms appeared, such as usually accompany fever from any cause. The animals were quiet, dull, and inclined to mope. They generally lost appetite, and often refused food altogether during the height of the fever. At this time rumination was suspended for a day or two. The bowels became irregular; as a rule there was constipation followed by diarrhœa. Occasionally the passage of blood-stained mucus was noticed. Little loss of condition was observed, or indeed possible, in the animals experimented upon, but the improvement which they nearly all began to show seemed to be delayed by the operation in some cases. In two of the cows, however, there was an obvious falling off for a week or two, but the animals picked up again subsequently.

2. Bloodlessness or anæmia.—This is a symptom less obvious, but more important than fever. It was pointed out by Smith and Kilbourne (1., p. 35) that the blood becomes thin and watery during the progress of natural Tick Fever, and that this change is due to destruction of the red corpuscles of the blood by the micro-organism. The number of corpuscles became much diminished, the extent being in proportion to the acuteness and severity of the attack. This effect is constant, and they regard it as "the essential phenomenon of Texas-Fever from which all the various pathological processes take their origin." (1, p. 39.)

The observations made on our cattle have demonstrated the occurrence of this anæmia in every animal experimented upon. Its degree and progress may be judged from Table, which shows the effect of the inoculation on the red corpuscles of the blood. The enumerations were made by means of a Gower's hæmacytometer.

Table IV.—Showing effect of inoculation on red corpuscles of theblood. Quantities in millions per cubic millimetre.

Cow.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.
Number before inoculation	6·3	6·6	5·8	5·5	5·8	5·5	5·3	5·6	5·4	5·4	4·8	5·2	5·6
Number after inoculation—													
Day 1.............	6·3	6·7	5·8	5·7	5·7	5·6	5·1	6·0	5·5	5·7	4·9	5·4	5·8
2...............	6·4	6·4	5·6	5·4	5·8	5·7	5·8	5·9	5·4	5·8	5·1	5·4	5·9
3...............	6·3	6·1	5·3	5·5	5·8	5·6	5·8	5·9	5·5	5·6	5·1	5·4	5·6
4...............	6·3	6·7	5·4	5·6	5·6	5·3	5·8	5·9	5·5	5·3	4·8	5·4	5·5
5...............	6·1	6·4	5·6	5·7	5·6	5·5	5·4	5·9	5·4	5·6	4·7	5·5	5·6
6...............	6·0	6·4	6·3	5·8	5·5	5·5	5·7	5·8	5·3	5·1	4·4	5·6	5·7
7...............	5·8	6·3	5·6	5·8	5·4	5·7	5·3	5·7	5·5	4·8	4·7	5·6	5·8
8...............	5·7	6·6	5·5	5·6	5·6	5·6	5·3	5·6	5·0	4·5	5·0	5·5	4·9
9...............	5·6	6·1	5·3	5·7	5·6	5·7	5·3	5·2	5·7	4·3	4·7	5·5	4·9
10...............	5·4	6·1	5·9	4·9	5·2	5·5	5·4	4·5	5·4	4·1	4·5	5·3	4·8
11...............	5·0	5·6	5·6	4·7	5·0	5·8	5·7	4·1	4·5	3·9	4·2	5·1	4·7
12...............	4·9	5·5	5·1	4·2	4·4	5·8	5·5	3·8	4·2	3·7	3·8	4·6	4·5
13...............	4·7	5·4	4·9	4·9	4·1	5·4	4·9	3·7	3·9	3·8	3·9	4·1	4·6
14...............	4·5	5·6	5·4	4·9	4·1	5·1	4·6	3·9	3·6	3·7	3·7	4·2	4·4
15...............	4·6	5·7	4·9	4·9	3·4	4·6	4·5	4·1	...	3·8	3·7	4·2	4·5
16...............	5·0	5·4	4·4	4·8	3·8	4·2	4·5	4·3	..	3·9	3·5	4·1	4·5
17...............	5·1	5·5	4·0	4·8	3·8	4·4	4·5	4·1	...	4·0	3 4	4·5	4·6
18...............	5·3	5·4	4·4	4·6	3·9	4·3	4·3	4·7	...	3·9	3·6	4·4	4·8
19...............	5·4	5·3	5·1	4·4	4·4	4·2	4·2	4·9	...	4·1	4·0	4·8	4·7
20...............	...	5·0	4·7	4·5	4·6	4·5	4·2	‹·6	...	4·6	3·9	4·7	5·1
21...............	...	5·3	4·8	4·4	4·5	5·1	4·8	4·9	...	4·8	4·2	4·8	4·9
22...............	...	5·2	5·2	4·4	4·7	5·1	4·6	5·2	...	5·2	4·4	5·1	4·9
23...............	5·8	4·6	5·0	4·7	4·9	5·6	4·2	4·9	...	5·3	4·3	5·2	5·8
24...............	...	4·2	5·0	4·6	5·0	5·4	4·9	4·8	...	5·2	4·5	...	..
25...............	...	4·5	5·1	4·5	5·1	5·3	4·9	4·9	...	5·1	4·6	...	...
26...............	5·8	4·3	5·1	4·6	5·2	5·2	4·9	5·1	...	5·2	4·4	...	...
27...............	...	4·8	5·0	4·7	5·3	5·1	4·8	5·2	...	5·2	4·8	...	...
28...............	...	5·0	5·1	4·8	5·6	5·1	5·0	5·1	...	5·3	...	..	...
29...............	...	5·0	5·0	4·6	4·9	5·2	5·2	5·1	...	5·2	...	...	...
30...............	6·1	5·0	4·5	4·4	4·6	5·3	5·3	5·1	...	5·3	...	...	...
31...............	...	4·8	5·1	4·5	4·9	5·4	5·0	5·1	...	5·3	...	...	...
32...............	...	5·1	5·0	4·6	5·0	5·5	5·4	5·1	...	5·4	...	...	...
33...............	5·9	5·3	5·0	4·8	4·9	..	...	5·5	...	...	...	...	...
34...............	...	5·2	5·0	4·6	5·2	...	...	4·8	...	...	...	...	...
35...............	...	5·1	5·0	4·9	5·1	...	...	4·9	..	...	..	...	...
36...............	...	5·3	5·0	4·7	4·7	...	...	4·5	...	...	...	...	..
37...............	...	5·4	4·9	4·7	4·9	..	...	4·9	...	..	...	...	...
38...............	...	5·4	5·0	4·6	5·1	...	...	5·2	...	...	...	...	...
39...............	...	5·3	5·0	4·5	5·2	...	...	...	...	...	..	...	...
40...............	...	4·9	4·9	4·8	5·4	...	...	...	...	...	...	...	...
50...............	...	5·0	5·3	5·2	6·0	...	...	...	...	...	...	...	...
60...............	...	4·4	5·6	...	...	...	...	...	...	...	...	...	...
70...............	...	4·8	5·5	...	..	...	...	...	...	...	...	...	...
80...............	...	4·6	...	...	...	...	...	...	...	...	...	...	...
90...............	...	6·0	...	...	...	...	...	...	...	...	...	...	...
100...............	...	5·8	...	...	...	...	...	...	...	...	...	...	...

The number of corpuscles per cubic millemetre of blood was ascertained before inoculation. The average for each cow is given in the top line of the table. By comparing these with the enumerations made after inoculation it will be seen that a diminution occurred in every case. Taking

Taking the first decided drop in the number as a guide, the decrease commenced between 7 and 14 days after inoculation, as a rule on the 10th or 11th day. Its full extent was reached between 12 and 23 days, usually by the 17th day. From this onward, recovery ensued, and the numbers became normal again at various times between the 23rd and 90th days. In the majority (10 of the 12 animals), the numbers were practically normal in a month after inoculation, but in the other two the time taken was 10 and 13 weeks respectively. These results are in accord with the statements of Smith and Kilbourne, who found that in Texas Fever the æmenia did not last longer than 3 or 4 months, and was usually recovered from in a much shorter time. (1, p. 42.) The loss amounted to between $\frac{1}{4}$ and $\frac{1}{2}$ the normal number of corpuscles, and was therefore milder than in natural tick fever, in which it amounted to between $\frac{1}{2}$ and $\frac{3}{4}$ of the normal. (1, p. 39.)

Other effects in the blood, such as changes of the form of the red corpuscles and leucocytes, and the presence of the micro-organisms, were observed by us; but as their description would unduly burden this report without serving any useful purpose, their consideration is held over for future separate communication.

3. Changes in the urine, especially "redwater" hæmoglobinuria, form the third important feature of Tick Fever. Redwater is not of constant occurrence in natural Tick Fever. It has been observed after inoculation, but was not found in any of our animals, although the urine was subjected to spectroscopic scrutiny in order to detect the faintest indications of it.

Chemical analyses of the urine showed the presence of an abnormal constituent (albumin) in 7 of the 11 cases in which it was examined. It was not great in amount, and soon disappeared as a rule, although in one case it persisted for 52 days. Its appearance indicates interference with the function of the kidneys, but this did not seem to amount to actual disease, since the variations in quantity, specific gravity, urea, &c., were not not greater than in healthy animals.

Neither jaundice, nor any other symptom indicative of liver disturbance, was observed by us.

(*e*) *The inoculation illness does not last longer than a month or six weeks as a rule.*

The duration of the inoculation illness is shown by the statements in the following table as made up of the three periods of incubation, reaction, and convalescence.

TABLE V.—Showing duration of inoculation illness.

Cow.	Blood.	Incubation.	Reaction.	Convalescence.	Total duration of illness.
		days.	days.	days.	days.
I	G	6	10	14	30
II	A	10	4	86	100
III	A	9	4	47	60
IV	B	7	7	36	50
V	B	8	9	31	50
VI	B	11	6	15	32
VII	C	10	10	12	32
VIII...............	E	4	10	19	33
IX	D	9	7	killed.	....
X	E	7	7	18	32
XI	E*	7	8	12	27
XII	F	8	6	9	23
XIII.........	E†	7	5	11	23

* Injected in divided doses (10) of 1 cc. each. † Injected intravenously.

The periods of incubation, during which the animal is becoming sick, and reaction, during which it is more or less acutely sick, have already been sufficiently commented upon. The two together extend up to the time of subsidence of the fever. But recovery did not immediately follow on this stage. Certain disease processes still went on, and were revealed by the conditions observed in the blood and urine. Nevertheless the general tendency was towards recovery, and this after-period was one of convalescence, ending with a return to the normal. It will be seen that the period of convalescence varied from 9 to 86 days, but it was completed in the majority of the animals (8 of the 12*) in less than 3 weeks.

The total duration of the illness, as reckoned from the time of inoculation to the end of convalescence, varied from 23 to 100 days, but was usually not longer than about a month (33 days or less in 8 of the 12).

We did not observe relapses, debility, nor any of the other sequelæ mentioned by Smith and Kilbourne as following on natural Tick Fever (1 p. 22). Convalescence was not more interrupted than in other diseases, and the normal when reached appeared to be well maintained. It is obvious, however, that remote effects, if there be any such, have not yet had time to appear. In view of the well-known healthy appearance of the southern animals in America, and the statements of authors that recovery from Tick Fever is usually complete, it is not expected that any further consequences of inoculation will be observed in the animals kept under observation.

(*e*) *The Effect of Inoculation on Meat and Milk.*

(1.) Meat.—No direct experiments were performed to ascertain the effect of inoculation on meat. The satisfactory determination of the nutritive value of a food-stuff necessitates prolonged and intricate physiological observations. No results important enough to justify the time and labour involved could have been obtained in the period covered by the experiments. Consequently, reliance was placed on the indirect method of determining the effect on the meat by inference from the effect on the general health and condition of the animal. This method is the one usually adopted in such cases, and is sufficiently accurate for practical purposes. It should be mentioned that we had an opportunity of examining the meat of the animal slaughtered during the period of reaction.

We

* One animal, No. IX, was slaughtered during the period of reaction.

We have to consider whether any of the disturbances of health following inoculation are such as would injuriously affect the meat. The influence of fever in producing unwholesomeness, and in hastening putrefaction, are too well known to need discussion. The bloodlessness in itself would do no more than spoil the appearance and impair the quality of the meat, which would be less nutritious, but not injurious. The amount of interference with the kidneys was not sufficient to damage the meat by retention of urinary substances. The loss of condition observed in two of the animals would interfere with the appearance and quality of the meat. In the slaughtered animal the meat was pale, rather flabby, and soft, lacking in fat and the prime appearance of good meat. But it did not show any sign of being diseased.

These deteriorating influences would all be operative only during the period of illness. When this had passed off, and the animals recovered, the meat would regain its usual qualities. Some of our animals became quite fat within a few weeks after recovery. The presence of the micro-organism in the blood of the meat would not deteriorate it, and, moreover, they are "quite rare in the blood of skeletal muscles" (meat). (I., p. 64.) There is no likelihood of the disease being communicated to man by ingestion of the micro-organisms, nor in any other way.

These considerations indicate that, at the most, inoculation will render meat less nutritious during the period of illness, but that no permanent injury is produced. As it is unlikely that the operation would be performed on animals intended for almost immediate slaughter, the temporary deterioration is of no practical importance.

(2.) Milk.—The animals experimented upon by us were all dairy cows, and were milked twice a day in the usual manner. As will be seen by reference to the Appendix, the milk was examined as to both quantity and quality.

(i.) Quantity.—The amounts given daily are stated in Table VI, which shows the effect of ino ulation on the yield of milk. They were estimated by weighing with a spring balance, as being simpler and more accurate than measuring.

Table VI.—Showing effect of inoculation on the yield of milk. Quantities in lb. Avoirdupois.

Cow.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.
Yield before inoculation.	12 to 14	15 to 16	17 to 18	14 to 17	11 to 13	14 to 17	17 to 20	15 to 17	9 to 11	18 to 19	13 to 14	13 to 14	10 to 11
Yield after inoculation—													
Day 1	13·0	16·0	18·25	16·5	13·25	17·5	18·0	15·0	11·5	18·5	14·0	14·75	11·75
2	11·25	15·75	17·5	17·0	13·75	17·5	19·0	15·0	10·0	18·0	13·25	16·25	10·25
3	12·75	15·75	18·0	16·75	13·0	16·0	19·25	15·0	15·0	17·25	14·0	16·5	11·0
4	12·5	16·0	18·75	16·5	13·5	17·5	18·5	15·0	11·25	18·75	13·75	16·75	11·0
5	11·75	15·0	18·0	16·75	13·5	17·0	20·0	14·5	10·25	18·75	13·75	17·0	11·75
6	12·5	17·0	20·25	16·5	13·0	16·75	19·0	14·75	14·0	18·0	13·75	17·0	12·0
7	9·0	15·75	19·5	16·0	12·5	15·0	19·75	13·5	7·75	17·75	13·0	16·5	11·25
8	7·0	15·5	19·0	14·0	12·25	15·5	19·25	12·75	1·25	17·75	13·5	14·75	11·5
9	7·25	14·5	18·25	13·25	11·25	16·0	20·75	11·5	·5	17·75	9·0	15·0	7·75
10	6·5	15·0	17·75	11·5	10·0	15·75	18·5	11·25	·25	15·5	8·5	13·5	4·75
11	6·25	15·0	17·75	8·5	10·0	15·0	18·5	10·75	1·5	12·75	9·0	7·5	4·75
12	8·0	13·75	17·25	8·5	8·5	14·5	17·5	10·5	1·75	11·75	8·5	3·75	5·0
13	9·0	13·75	17·25	9·0	4·75	13·0	13·25	11·0	2·25	14·25	8·75	3·0	7·25
14	9·75	13·0	17·25	11·25	3·5	14·0	8·5	11·5	2·5	14·25	11·75	5·25	8·0
15	10·25	15·0	17·0	12·0	4·5	6·5	9·25	11·75	2·0	14·25	10·5	5·75	9·5
16	11·25	14·0	18·75	12·25	5·5	8·0	13·0	12·25	...	14·5	11·0	7·5	9·0
17	11·75	14·0	17·5	11·25	6·5	11·25	13·25	13·25	...	16·25	12·25	8·75	9·75
18	11·25	14·0	18·0	11·25	6·75	12·0	13·75	13·0	...	17·0	13·25	9·5	9·75
19	11·5	13·25	18·5	12·5	8·0	13·0	15·0	14·75	...	17·5	12·75	10·0	11·0
20	12·25	13·0	17·5	12·25	8·5	12·75	15·0	14·75	...	18·75	13·75	10·25	10·75
21	13·0	13·75	17·25	13·25	9·5	14·25	15·5	13·25	...	18·75	14·25	11·25	10·5
22	...	13·0	18·0	13·25	10·5	14·25	15·75	14·25	...	19·0	15·0	11·75	10·0
23	...	13·25	17·75	14·0	10·5	14·25	16·0	14·5	...	...	...	12·5	10·25
24	...	13·5	19·75	14·0	10·25	14·25	16·5	14·75	...	...	...	12·5	11·25
25	...	14·0	20·0	13·5	10·0	15·25	16·75	14·75	...	...	...	13·5	...
26	...	14·75	...	12·73	9·75	...	17·0	15·0	...	...	...	...	...
27	...	14·25	...	12·75	10·75	...	...	16·0	...	...	...	...	...
28	...	15·5	...	14·25	12·25	...	...	...	...	...	...	...	...
29	...	16·0	...	14·75	...	...	...	...	...	...	...	...	...
30	...	...	...	...	...	...	...	...	...	...	...	...	...

As the yield varies slightly from day to day, we have taken the usual limits of the yield before inoculation as a guide in determining the effect of inoculation. These limits are given at the top of the table. By comparing them with the amounts ascertained after inoculation it will be seen that a diminution occurred in all cases.* The decrease commenced between five to thirteen days after inoculation, but usually before the 10th day. It continued for two to eight days longer, and the full extent was reached between ten and fifteen days after inoculation. The yield then increased again, and the lower limit of the normal was regained between eighteen and twenty-eight days after inoculation. In five of the cows the improvement continued, and the former high limit was exceeded, but in the other seven the yield remained between the previous extremes.

Estimates, based on the figures obtained, showed that the total loss of milk in our whole herd of 11 cows † amounted to about 50 gallons. Reckoning milk as worth 6d. a gallon to the producer, the money value of the loss would be 25s. on the herd, or 2s. 3d. per cow. But apart from the fact that our cows were poor milkers at the best, the estimates are based on the assumption that the milk would be used throughout. Although, as will be seen, this would not be of serious consequences, most dairymen would probably elect to avoid all risks and discard the milk during the febrile period at least. This would mean the loss of a week's milk, as a rule. Taking 20 lb. a day as a fair yield, the loss would amount to 140 lb., or 14 gallons per week, equivalent to a money value of 7s. per cow. It

* No. III is an apparent exception. This cow was improving in her yield daily at the time she was inoculated, and the amount increased during the incubation period to 20·25 lb. This fact is taken into consideration, and her normal yield regarded as 18 lb. per day.

† No. IX, which was killed, and No. III, in which effects were exceptionally slight, have been excluded from the estimate.

It would obviously be best to inoculate the cows one by one as they became dry, and so avoid all loss of milk. The danger of abortion resulting during the fever should be remembered, and the operation performed well before the expected time of calving.

(ii.) Quality.—Estimations of the specific gravity, total solids, fat, and solids not fat, were used as the basis for the determination of the effect of inoculation on the quality of the milk. This part of the work was carried out in the chemical laboratory of the Health Department by the Government Analyst. The results of the analyses before and after inoculation are given in the records in Appendix 2. Their examination will show that no appreciable change in quality occurred after inoculation. The milk remained up to the standard composition in all respects throughout. The total solids and fat show a proportionate increase during the fever, but this merely means that they did not diminish to the same extent as the quantity. The specific gravity was lowered owing to the relatively greater amount of fat present. On recovery from the fever the quantities soon became readjusted to their former proportions.

No alteration in taste, appearance, or keeping qualities was noticed, and throughout the whole time of the experiments, except during actual fever, the milk was used for drinking and domestic purposes by several persons without ill effects.

Smith and Kilbourne state that some observers have recorded the sudden and partial cessation of the milk secretion during natural Tick Fever, but that they had no opportunity of observing this symptom (1 p. 20). Our results are in accord with this statement, but they show that after inoculation the decrease in the yield is temporary only, and that no serious effect on the dairying industry need be anticipated. The changes were not in any way special, but such as might occur in any febrile disease.

(*f*) *Comment.*

The facts above recorded show that the effects of inoculation on cattle are the same as those of natural Tick Fever, but very much milder as regards both fatality and the severity of the illness.

It is to be noted that there is a double mortality to be reckoned with, the primary fatality of inoculation and the secondary fatality on exposure of the inoculated animals to ticks. Both are slight, and together amount to less than would be caused by the ticks in uninoculated cattle.

Apart from the fatality, the inoculation illness does not entail serious consequences. The animals usually recover in a month or six weeks, although occasionally an individual beast may remain an invalid for two or even three months. The observations on milk and meat have had the satisfactory issue of showing that the effect on these products is slight and practically unimportant. In Appendix 1 will be found graphic records showing the relationships between the fever, blood destruction, and milk-yield during the periods of reaction. The charts need no special explanation, their purpose being merely to give a sort of bird's eye view of what happens during the acute stage of the illness.

The possibility of inoculation introducing diseases other than Tick Fever has been suggested more than once. Although the risk is probably not great, its existence must be admitted if the operation be performed by unlearned persons. It is essential to have the foreknowledge that the animal whose blood is to be used is free from communicable disease. The only safeguard is careful preliminary examination by a skilled individual. It would, perhaps, be advantageous to establish in each district a stud of specially selected healthy animals for inoculation purposes.

It is not to be denied that inoculation has its defects. The existing method is crude and uncontrollable in its results, but it is the only one at our service at present. It remains for the future to decide whether or not it can be improved upon. In any case the defects are not such as to contraindicate its practice; in the mass the balance turns in its favour. Its advantages are a clear gain; its defects such as would be many times magnified by the incidence of Tick Fever upon uninoculated animals. But the fact that inoculation is not an unmixed blessing must be recognised. It has its limitations, and a clear understanding of them is necessary in order to avoid the disappointments which would result from false impressions of the security it offers. The method must not be relied upon for more protection than it can possibly furnish. With this object alone have the defects been given prominence in this report. They are not to be regarded as prohibitive of the method, but indicative of its cost. In view of all the evidence it must be concluded that, in the face of threatening tick invasion, protective inoculation is a perfectly justifiable procedure.

PART 3.—NOTES ON PROTECTIVE MEASURES OTHER THAN INOCULATION.

However valuable as a protective measure against Tick Fever, inoculation will not prevent tick infestment. The two things are distinct and separate, and have to be contended against on different principles. Sufficient evidence has been submitted in the foregoing pages to show the need for strenuous opposition to the ingress of the cattle ticks into this Colony. With a view of ascertaining how far the measures at present in vogue are capable of imposing a barrier in the path of the parasites, special inquiries were made concerning them during our Queensland visit. The opinions expressed were so numerous and varied that the task of sifting the chaff from the grain is by no means an easy one. The following notes must be regarded merely as tentative efforts in that direction

The principal measures directed against the dispersal of ticks are three in number, viz.:—

(*a*) Quarantine.
(*b*) Dipping and kindred measures.
(*c*) Crush inspection.

(*a*) The value of quarantine depends on the conditions under which it is applied. It may be directed against agencies coming from without, in which case it is a method of exclusion, or it may be directed against agencies which have already gained an entrance, in which case it is a method of isolation. As applied to restrict the dispersal of cattle ticks there are important differences between the two methods.

The method of exclusion, which prohibits the importation of stock from areas known to be associated with tick infestation is already in operation in this Colony. Of its advisability there can be no doubt, the question is whether it can accomplish its object of preventing the ingress of the ticks. Ticks do not wander far on their own account, their dissemination over long distances depends on their being transported by travelling stock. It may be considered, therefore, that the exclusion of such stock will be effective so long as there is a sufficiently wide "buffer" area between the tick-infested country and our Borders.

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The method of isolation, or internal quarantine, consists of the shutting up of tick-infested cattle within their own pastures. The need for this measure in this Colony has not yet arisen, but it has been used in Queensland. As its application has caused considerable dissatisfaction amongst stockowners, its discussion in this report may not be deemed superfluous in view of possible contingencies.

The value afforded to the method of exclusion, by the distance required to be traversed by the ticks, is lacking in the case of isolation. Transport over short distances can be effected by agencies which do not exist when the journeys are long. It is said, for instance, that the ticks can be carried by marsupials, birds, snakes, &c., on the clothing and blankets of human beings, or even blown for some distance attached to grass seeds. They have at times "broken quarantine" in a quite unaccountable manner. Under the circumstances, it is not surprising to find that isolation ultimately fails.

The various modes of transport make it extremely difficult to establish and maintain a satisfactory quarantine. A single fence has usually been of little service. A double fence—as along a railway line—has been passed through. A natural barrier such as a river or range of mountains has sometimes been effective, sometimes not. It is therefore probable that any isolation that it would be possible to impose under ordinary circumstances furnishes a but imperfect protection. Indeed, the history of the ticks in Queensland teaches that sooner or later these parasites will become disseminated in spite of the isolation of the infested cattle.

It does not follow that isolation is altogether useless. Cattle furnish the usual and readiest mode by which ticks are transported, carriage in other ways being more or less accidental and uncertain. So that isolation of the cattle, though not absolutely preventing the dispersal of the ticks, does impede their progress to some extent. The delay effected will generally be long enough to permit of the taking of other measures, *e.g.*, inoculation. These considerations suggest that isolation should only be used as a temporary measure. The more or less permanent closing up of cattle in their own pastures, perhaps ultimately to die of starvation, is of questionable expediency. The hardship inflicted upon the owner of the cattle does not seem warranted by the indefinite amount of protection gained. Moreover, it becomes very expensive to maintain. On the other hand, a temporary isolation, for a few weeks at most, whilst not greatly embarrassing to stockowners, nor unduly expensive, will serve every purpose that can be expected of the measure.

(*b*) Dipping.—The value of dipping is a disputed point. Some of the dips in use undoubtedly kill ticks, but the dipping can rarely be so conducted as to ensure the destruction of every tick on a beast. The extensive multiplication of the ticks escaping destruction is only a matter of time, and the plague soon becomes as bad as ever. The repeated dipping advocated by some is said by others to seriously damage the cattle. The principle is deeply rooted that cattle subject to Tick Fever should be left undisturbed as much as possible.

Dipping, therefore, does not furnish any security against dispersal of ticks; but it has its uses. It has been mentioned above that, apart from conveying Tick Fever, the ticks may cause injury by their mere parasitism; that some animals suffer more from ticks than Tick Fever. The removal of the bulk of the ticks from such animals would afford the relief, albeit temporary, necessary to enable them to regain sufficient vigour to make an ultimate recovery. In such cases dipping would find a legitimate and useful application.

What has been said of dipping applies also to kindred measures, such as smearing with unguents and parasiticides.

(*c*) Crush Inspection.—Concerning the inspection of animals in a crush, it may be said that if the ticks be more or less mature, they will probably be detected, if they be in the larval stage, no bigger than pins heads, they will probably not be detected. The chances are that any infested herd will show ticks in all stages, and so the inspection will be of service. But it is conceivable that in some particular herd the ticks may have been recently acquired (within a week), and by their small size escape observation. Then the inspection will fail, and the ticks gain an entrance. The general testimony is to the effect that failure may occur even with an experienced inspector, and that nothing less than casting and minute examination offers any security.

Crush inspection, therefore, offers only a partial protection against the ingress of the ticks. It may have some value in limiting the number of entrances, and in that way enabling other measures to be concentrated upon particular places instead of being scattered all along the line. It may have an additional moral value, for whilst inspection is insisted upon, unscrupulous individuals will not try to import grossly tick-infested cattle.

CONCLUSION.

In the preceding pages the endeavour has been made to present and analyse the evidence concerning the measures upon which reliance will have to be placed in defending the herds of this Colony against ticks and tick fever. Care has been taken to submit both sides of each question; our armament has been examined as to its weaknesses as well as its strength. There remains for consideration the practical question of how to make the best use of the forces at our disposal.

There is no doubt that exclusion, dipping, and crush inspection should continue to form the first line of defence. The information gleaned concerning these measures is to the effect that they will not render our position impregnable. They appear to have been individually and collectively futile in preventing the ultimate progress of the ticks. But they have the merit of imposing a temporary check. The comparative importance of the method of exclusion depends upon its being a long range measure, and it will disappear when the ticks come to close quarters. No system of quarantine can withstand the repeated multiple attacks which may then be expected. Nevertheless, in spite of the deficiencies of this and the other two measures, they may in combination suffice to resist the invasion of ticks for a considerable time to come. Their observance, therefore, should be subjected to rigid and continuous vigilance. It will be time enough to abandon them when the guard they form has been broken through.

The probability that this will happen sooner or later makes it important to attend to our internal resources. The inadequacy of isolation and dipping, except as temporary expedients, throws us back on inoculation as our principal protective weapon. It has been pointed out that whilst inoculation is capable of affording very decided aid in combating tick fever, this benefit is not to be gained without sacrifice. It is worth while to reflect upon the means by which the loss may be reduced to a minimum.

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We have seen that immunity against tick fever only becomes complete and lasting as the result of repeated infection. As satisfactory and durable immunity is not secured by a single attack of the natural disease, so the protection of cattle is not finally effected by a single inoculation. The condition of acquired immunity is an artificial one, and the tendency in all such cases is reversion to the natural state. In animals immunised against anthrax, diphtheria, snake poison, &c., it is necessary, in order to keep up the immunity, to occasionally inject virus, toxin, or venom. In vaccination against small-pox, the protection afforded by the infancy vaccination becomes diminished during growth, and requires to be supplemented by revaccination after puberty. By analogy, it is to be expected that the acquired immunity of cattle against tick fever, in the absence of reinfection, will gradually become lessened as time goes on.

This reasoning induces the suspicion that we may prepare for tick infestment too long beforehand. If we inoculate now, the immunity may be lost again before the ticks come. But on the other hand it is necessary to be ready, for the ticks may come at any time. There are two courses open to us. We can either reinoculate annually until the ticks arrive, or we can attempt to secure an enduring immunity by inoculating and reinoculating several times in succession, with, say, a month or six weeks interval between each operation. The first suggestion is based on the view that inoculation is probably most valuable when performed shortly before exposure to ticks, and the interval of a year is chosen as being the time during which the immunity conferred by a single attack has been shown to last, in some cases at least. The second suggestion is based on the view that the immunity becomes intensified by repeated attacks, and is therefore likely to last longer. It has the advantage of picking up the animals that escape satisfactory treatment on the first occasion. It is impossible to be more precise about these suggestions, because they have never been put to the test. But there is little room for doubt that in this Colony, where the exact time of the advent of the ticks is a matter of uncertainty, reinoculation in some form or other is the wisest plan. The choice of a method must be governed by practicability, but all direct and indirect evidence indicates that the immunity, once obtained, must be maintained by repeating the infection within a limited interval of time. This advice has the recommendation of being an imitation of the natural course of events consequent on tick infestation. If the ticks come, they may be relied upon to perform the reinoculation on their own account.

It may be questioned, however, whether it is advisable to inoculate all animals until the closer approach of the ticks. In view of the rapidity with which the immunity can be produced, the inoculation of the older cattle might be advantageously deferred until actually necessary, the operation being restricted in the meantime to the young stock. In this way there will be avoided the fatality attendant on inoculation, which mostly occurs in adult cattle. The present generation of old cattle might never need to be inoculated, but we should see to it that our future herds consist of highly-protected animals. By commencing as soon as possible, we shall gain the time necessary to properly immunise the cattle, and the advantage of being able to conduct our operations with a calmness and deliberation which will be impossible after the actual warfare begins.

The total outcome of the above considerations, as to the manner in which we should bring our forces to bear to restrict the consequences of tick invasion, is to the following effect :—We should energetically maintain our border defences, and we should set about rendering our internal position as secure as possible by inoculation and reinoculation of our cattle. The young stock should be inoculated at once, and the old stock later on if necessary. The immunity conferred by the first inoculation should be supplemented by systematic reinoculation according to some definite plan, until the arrival of the ticks makes it no longer necessary. This, or something like this, must be our plan if we are to avoid the disaster which has befallen our Queensland neighbours.

Sydney, December 29th, 1898. (Signed) FRANK TIDSWELL.

LIST OF THE LITERATURE REFERRED TO IN THE REPORT.

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5. Report of the Chief Inspector of Stock and Registrar of Brands. Brisbane, 1897.

6. Queensland Agricultural Journal, V. III, Pt. 3, Sept., 1888, p. 235.

7. Dr. J. Sidney Hunt and Mr. William Collins. Report on Tick Fever. Brisbane, 1896.

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NOTE.

It has not been thought necessary to publish the lengthy appendices *in extenso*, but the following brief description, together with the extracts quoted in the report, will serve to show that the investigation has been conducted with thoroughness and scrupulous attention to scientific detail.

The experiments were performed on thirteen dairy cows supplied from the Hawkesbury Agricultural College, and accommodated at the Maritime Quarantine Station, North Head, in buildings specially erected for the purpose. The general management of the cows was such as would have existed in an ordinary dairy. After allowing as much time for the animals to settle down in their new quarters as the urgency of the matter permitted, they were subjected to a series of preliminary observations, in order to ascertain their exact state of health before commencing operations. When this had been done the general plan was to inject the animals with either recovered or virulent blood, note the effects, and later on inject with virulent blood to test the immunity. During the whole time there was kept going the series of observations to be mentioned below, and in all cases care was taken to make check observations on untreated animals.

The inoculations were made with a previously sterilised syringe, the needle being usually inserted under the skin just behind the shoulder. The operation was always performed with strict surgical cleanliness, the part being shaved, washed with soap and water, and then with carbolic acid lotion, before injection. The injection produced a swelling which passed off within twenty-four hours, and, beyond slight inflammation occasionally, no local ill effects were observed.

Both recovered and virulent blood were in the first instance obtained from Queensland, the Government of that Colony kindly complying with our request for a supply. When the disease had been set up we were able to obtain further supplies of blood from our own cows.

A detailed record was kept containing the complete data concerning the treatment and progress of events in each of the animals experimented upon. The particulars included observations on the pulse, temperature, blood, milk, urine, bowel discharges, etc. The pulse was taken twice daily between 3 o'clock and 5 o'clock in the morning and 3 o'clock and 5 o'clock in the evening. The temperature was taken twice daily immediately after milking. The blood was examined every day during the period of illness, and after that every few days till the experiment terminated. The examinations comprised estimation of the hæmoglobin by Gower's hæmoglobinometer, with occasional check readings with Fleishl's hæmometer, and enumerations of the corpuscles by means of Gower's hæmocytometer. The milk yielded was weighed on a spring-balance immediately after milking. Chemical analyses of milk were made three times a week. The samples were taken from the milking-pail into sterilised flasks, the milk being well mixed. They were conveyed to the Chemical Laboratory of the Health Department within a few hours afterwards, where their analysis was at once put in train by the Government Analyst. Samples of urine were obtained as often as was considered necessary, and were analysed in the Biological Laboratory of the Health Department. The records further contained information upon matters ascertained by ordinary physical examination, such as general health, appetite, condition, habits, etc.

Report

Report on the initiation of protective inoculation against Tick Fever in the North Coast Districts.

Being aware that Dr. F. Tidswell, Principal Assistant Medical Officer to the Government, is about to furnish a report dealing fully with the nature and effects of protective inoculation against Cattle Tick Fever, it is proposed to confine this report to the principles underlying the application of this procedure as now being initiated in the North Coast District.

The method adopted has been formulated upon the results of experiments carried out in Sydney and information gathered during the recent visit to Queensland in association with Dr. Tidswell.

Protective Inoculation consists of the subcutaneous injection of five cubic centimetres (5 c.c.) of defibrinated blood taken from an immunized or "salted" animal. That is one that has suffered from a severe attack of Tick Fever naturally or artificially acquired. Repeated experiments have proved that the blood from an animal salted by artificial inoculation possesses the same protective properties as that from one whose immunity has been naturally acquired.

The Establishment of Salted Stock.

The primary and most important step in initiating inoculation is the establishment of a stock of thoroughly "salted" but otherwise healthy cattle for the sale of blood

Healthy young cattle (calves and yearlings) are best adapted for this purpose as they are easier handled and operated on. Moreover they are naturally less susceptible to the virulence of the fever, and are generally constitutionally healthier than adults. Still as tuberculosis affects cattle of all ages, it is sound practice to subject all intended for this purpose to the tuberculin test. The animals must indisputably withstand the test.

In order to thoroughly "salt" these "stock cattle" it is recommended that they receive three inoculations as follows, viz.:—

(*a*) A first inoculation of 5 c.c. of recovered blood. This should produce a reaction within four to twelve days, after which a period of four to eight weeks is allowed to elapse for complete recovery to take place. When they are subjected to,—

(*b*) A second inoculation of 10 c.c. of recovered blood. This inoculation is not considered indispensible in cases where the temperature records of animals taken after the first inoculation indicate that a severe reaction has taken place. It is however, recommended to be practised when large numbers are operated on at the one time. After this inoculation the cattle are kept under observation for fourteen days, and if no reaction follows,—

(*c*) A final inoculation of 10 c.c. of virulent blood; the strength of which should be demonstrated by inoculating an unprotected beast.

Should the final inoculation of proved virulent blood fail to produce a reaction, and in no way inconvenience the animals so treated, the blood of these animals may be regarded as well adapted for the purpose of conferring immunity to others by inoculation. In recommending this process the object is to produce an immunity of *high degree* and *lasting influence*.

The extent to which Inoculation is recommended to be carried out at present.

Owing to the quarantine measures adopted Tick Fever is at the present time unknown in this Colony. The opinion that ticks must eventually invade our herds along the coast districts seems to be fairly unanimous. The ticks might appear suddenly in the near future or may be not for a considerable time. Consequently inoculation of all cattle is not thought advisable at present, as unnecessary loss may be thereby involved.

To at once commence inoculating young cattle (calves and yearlings) and thus gradually prepare to minimise the loss entailed by a sudden outbreak of Tick Fever is considered a justifiable precautionary measure, and is therefore strongly recommended. The dry cows should be inoculated when conditions are favourable, and the remainder of the herds when circumstances warrant such procedure.

Conditions to be observed with regard to Inoculation.

Experience has taught that in order to minimise the loss resulting from inoculation the following conditions must be observed, viz.:—

(1.) The cattle must not be travelled long distances either before or after inoculation.

(2.) That cattle in moderate condition withstand the effects of inoculation better than those in prime or low condition.

(3.) The operation must be conducted with as little noise and bustle as practicable.

(4.) The cattle under treatment must be placed in paddocks containing a good supply of grass and water, and there allowed to remain undisturbed.

There should be little or no difficulty in conforming with these conditions when inoculation is being carried out on large stations.

In treating the small herds of various owners some difficulty may be met with. This, however, may be overcome by having properly salted animals distributed to various centres. The inspector of stock for the district, or a licensed operator, could then deal with the small lots individually or collectively; in the latter case the various owners could conjointly arrange for the accommodation of their cattle at a convenient and suitable place, where the inoculation could be carried out.

Faulty Treatment and its Prevention.

Many cases are heard of in Queensland, in which inoculation has not conferred upon the animal so treated the desired protection.

Owing to the satisfactory results derived from inoculation, when carried out either experimentally by scientists or on a large scale by reliable persons, one is inclined to the belief that faulty treatment is the cause of failure in many instances.

This

This faulty treatment which creates a deluded idea of security, may originate from (*a*) *the use of improper blood*, or (*b*) *a sufficient dose of blood not being administered.*

(*a*) As previously stated, all blood used for inoculating should be taken from animals that have been thoroughly salted. It is further recommended that two or more susceptible animals, that have been previously well handled, be set apart and inoculated with the blood used on each occasion. The temperatures of these animals should be taken daily while under treatment. A complete record of temperatures is thus obtained, which is of great value in ascertaining the efficacy of the blood used.

(*b*) Failing to inject a standard dose (5 c.c.) of blood may be due to the following causes:—(1st.) The apparatus not being in proper working order. This, however, is avoided by testing the apparatus immediately before operating, for leakage. The system of using a syringe of 10 c.c. capacity, while the dose injected is but 5 c.c., is good practice, as it admits of the presence of a certain quantity of air or froth within the syringe without influencing the dose injected, so long as the syringe is worked in a vertical position. (2nd.) Inoculation being performed too hurriedly: To check this the operator is advised to allow an interval of about ten seconds duration from the time of actual injection until the withdrawal of the needle from the beast under treatment. If the pressure exerted in ejecting the blood from the syringe is great and the flow from the needle obstructed, a damming back of a certain quantity of blood within the rubber tubing of the apparatus occurs. On withdrawing the needle this quantity of blood is lost, the loss being at the expense of the dose. This mishap is, however, obviated by raising the skin slightly, so as to form a space subcutaneously for the reception of the dose and by observing the interval just mentioned, which allows time for the pressure originating from the distended walls of the rubber tubing to complete the injection.

Re-inoculation Recommended.

Experience has taught that, when inoculating large herds, a certain small percentage of the animals treated do not react, and others exhibit symptoms of doubtful value. Consequently it is recommended that all cattle treated should be subjected to a second inoculation within four to eight weeks' time from the first. In this manner it is hoped to bring about a reaction in those that previously escaped, and it is only with such animals that extra risk is involved. The second inoculation will not affect those that reacted to the first, while a greater degree of protection may be conferred. The security offered by such procedure adequately repays the trouble involved.

After Treatment.

It is necessary to place the cattle immediately after inoculation in paddocks containing a good supply of grass and water, under the care of a reliable man, where they should be left undisturbed. It is not advisable to remove them until after the expiration of six weeks from the date of inoculation.

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6th January, 1899.

Sydney: William Applegate Gullick, Government Printer.—1899.